

GREENING HEALTHCARE DELIVERY: A PATH TO SUSTAINABLE DEVELOPMENT IN SILESIAN PUBLIC HOSPITALS

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Purpose: The study aimed to identify ecological innovations implemented in processes performed in Silesian public hospitals. Moreover, it was aimed to assess the degree of greening healthcare delivery by the departments in Silesian public hospitals.

Design/methodology/approach: The research goals were achieved by a quantitative survey, which was carried out in the Silesia region.

Findings: The study indicates that public hospitals are implementing ecological innovations in their processes, but the advancement of these units in this area is moderate. It was found that ecological process innovations introduced by Silesian public hospitals during the last three years included innovations in recycling, reduction of CO₂ emission, material savings, and waste minimization.

Research limitations/implications: The main limitation of the study was that the research was conducted only among hospitals in Silesia.

Practical implications: The study's results can be used when creating instruments and regulations to support the implementation of sustainability by healthcare units.

Originality/value: This study provides information on the diffusion of ecological innovations by Silesian public hospitals. Thus, it extends the knowledge about greening healthcare delivery in Poland.

Keywords: ecological innovation, eco-innovation, green innovation, sustainable development, healthcare units.

Category of the paper: Research paper.

Introduction

Challenges that have arisen in the global economy due to decreasing natural resources, changing climate conditions, degradation of the environment and entire ecosystems (Lopes, Cruz Basso, 2023), as well as the growing gap between the highly developed countries and the

rest of the population (Matejun, 2009), have caused that in the 21st century, the concept of sustainable development has become popular. The fundamental idea behind this concept, according to which humanity has the opportunity to meet its present needs without compromising the ability of future generations to meet theirs (World Commission on Environment and Development, 1987, p. 16), has begun to guide the behaviour of most informed consumers. It has also directed the activities of some commercial and non-commercial organizations, which started to reduce their negative impact on the environment by introducing ecological innovations into everyday business practices. These innovations took a variety of forms. Some organizations have implemented green products, while others have changed their products or services in such a way as to reduce their negative impact on the environment. Still, other organizations modified the processes occurring within them. Solutions that emerged in this area included waste reduction and recycling, using environmentally friendly technologies and materials, using energy-efficient equipment and buildings, and introducing sustainable transportation systems (Sieg et al., 2023). Through such projects, many organizations have achieved environmental, economic, and social benefits (Chuang et al., 2022), such as cost reductions, productivity improvements, and increased reputation (Carvalho et al., 2018).

Ecological innovations have also attracted the attention of healthcare units. Their activities in this area have become necessary, as the healthcare sector is responsible for 4.4% of global carbon dioxide emissions (Health Care Without Harm Report; WUF11). In Poland, the healthcare sector generates, on average, 44 tons of medical waste annually, 90% of which is hazardous and mainly infectious (Supreme Chamber of Control, 2014, p. 16). To mitigate their negative environmental impact, healthcare units in the Polish market have begun to introduce changes in the processes accompanying the provision of their services. Thus, green healthcare delivery has begun to develop in Poland. However, little is known about all these changes in the healthcare sector. A literature review indicates that studies on environmental innovation conducted in Poland have generally concerned commercial organizations (Derej, 2017; Rutkowska, Pakulska, 2018) and only selected were focused on public organizations. Healthcare units have been only marginally in the interest of researchers in this area. Filling this cognitive gap formed the basis of the study, the results of which are presented in the article. That study aimed to identify the types of ecological innovations implemented in processes performed in Silesian public hospitals. Additionally, the study aimed to assess the degree of greening practices in the public hospitals of the Silesian region. The established goals were achieved by a quantitative survey, which was carried out in the Silesia region.

1. Greening of organizations based on ecological innovation

The globalization of economic processes, increasing consumption, and economic development have contributed to the ongoing destruction of the natural environment. Consequently, many countries have implemented environmental regulations, stimulating various organizations to consider environmental protection (Lopes, Cruz Basso, 2023). As a result, there have been many changes in the management of organizations, which have been legally forced to consider not only economic issues (improving profitability, efficiency, creating added value for stakeholders) but also ecological aspects in their plans. Organizational undertakings considering ecological aspects have led to the implementing of a sustainable development concept into practice (Matejun, 2009). One manifestation of organizations embracing sustainable development has been their focus on optimizing processes with limited environmental exploitation. From this perspective, sustainable development has inspired many firms to create new solutions for environmental issues, known as ecological innovations (Sieg et al., 2023).

The concept of ecological innovations was first proposed by Fussler and James in 1996 (Domaracká et al., 2023). Today, ecological innovations are defined as the production, assimilation, or exploitation of a product, production process, service, or management method that is innovative for the organization (developed or adopted) and, throughout its lifecycle, results in a reduction in environmental risk, pollution, and other negative effects of resource use (including energy consumption) compared to relevant alternatives (Miao et al., 2023). Ecological innovations can be considered innovations with a lower environmental impact, regardless of whether environmental factors are the primary motivation for their development or implementation (del Rio et al., 2017). Ecological innovations in products or services enable businesses to produce goods with lower energy and material inputs, ultimately reducing costs. They also improve business performance by enabling organizations to comply with legal requirements, reducing administrative and managerial costs, creating jobs that enhance employee satisfaction, and lowering supply chain costs. Moreover, these solutions facilitate the implementation of innovations by fostering a positive organizational culture toward innovation, allowing companies to achieve sustainable competitive advantages (Al-Hanakta et al., 2023). Therefore, by implementing ecological innovations, organizations can achieve both environmental benefits and positive economic effects, such as cost reduction, improved results, increased added value for customers, better resource management, and a competitive edge, as well as creating a friendly workplace.

2. The healthcare units as entities implementing ecological innovations

Healthcare units, like other contemporary organizations, have begun to implement green innovations to mitigate their negative environmental impact resulting from high CO₂ emissions and large resource consumption (Šūmakaris et al., 2021). The Health Care Without Harm report provides the scale of the significant level of emissions generated by the healthcare sector. It shows that if the healthcare sector were considered a country, it would be the world's fifth most significant source of greenhouse gas emissions (Health Care Without Harm Report; WUF11). Therefore, many countries are striving to reduce the pollution created by healthcare units by setting themselves the goal of meeting the requirements of the Paris Agreement and the European Green Deal, which pledge, among other things, to reduce the effects of global warming and thus keep temperature increases below 1.5°C, reduce emissions by at least 55% by 2030 (compared to 1990), and make Europe a net zero continent in terms of carbon emissions by 2050 (Puls Medycyny, 2022).

Healthcare units may be encouraged to adopt green innovations because of the economic benefits they can provide them (Shah, Ahmed, 2019; del Río et al., 2012). These benefits include managing resources more efficiently, reducing costs by avoiding an environmental fee, achieving energy and water consumption savings, and being competitive. They are essential for healthcare units because healthcare in all countries is costly. Many countries, including Poland, are struggling with the high costs of healthcare entities. In Poland, managing healthcare units involves managing limited financial resources and a shortage of medical staff (Wiśniewska, 2021). In addition, due to the persistent inflation in recent years, managers of healthcare units have to cope with the rising cost of medicines and medical supplies, as well as the high cost of electricity and water, which are essential in the treatment process. The increase in the cost of healthcare units is also caused by demographic changes - an aging population, diseases of civilization, deteriorating health, and an increase in the percentage of the population burdened with chronic diseases and disabilities (Szymborski, Marciniak, 2015). Because of this, the number of patients is increasing, and thus healthcare costs are rising sharply (Pawłowska, 2015).

The willingness of healthcare units to reduce costs may be an additional factor determining their efforts toward ecological innovation (Šūmakaris et al., 2021). However, healthcare units may not experience cost reductions from implementing ecological innovations such as those obtained by organizations in other sectors. That is due to the peculiarity of health care units, which lies in the fact that the priority in health care units is always the patient's health. Consequently, solutions from other sectors cannot be implemented in healthcare units (Dymyt, 2018).

3. Methodology

The achievement of the set goal was realized based on a quantitative study conducted as part of the project 'ECONomics4Climate Diverse Trajectories of Research in Economics of Climate Change.' This project was funded by the Metropolitan Fund for the Support of Science (Research Task No. 3). The research focused on the greening processes implemented in the wards of public hospitals. It was assumed that colocalization constitutes a set of actions taken in hospital wards toward minimizing negative environmental impact. For this article, only a portion of the data obtained from this study regarding ecological process innovations was utilized.

The study respondents were mid-level managers in the medical sector, such as ward directors or heads of clinics, as well as financial, economic, analysis, and cost or medical statistics departments responsible for recording the number of hospitalized patients and employed staff. The study was conducted from July to September 2023 among 60 departments of public hospitals located in the Silesian Voivodeship: Bytom, Chorzów, Dąbrowa Górnicza, Gliwice, Jaworzno, Katowice, Piekary Śląskie, Ruda Śląska, Siemianowice, Sosnowiec, Świętochłowice, and Zabrze. The survey questionnaire was sent to 328 departments, and the response rate was approximately 18%. Hospitals representing all levels of qualification for the basic hospital security system, as defined in Article 95 of the Act of August 27, 2004, on health care services financed from public funds (Journal of Laws 2021.0.1285), participated in the study.

Data were collected using a questionnaire specifically prepared for the study, consisting of 11 statements regarding ecological process innovations (Green process innovation), questions about the number of employees and the number of hospitalized patients per year, as well as metric questions. The questionnaire items used to construct the greening index were drawn from the literature, including the study by Junaid, Zhang, Syed (2022), Wu (2013), and Singh et al. (2020). Table 1 presents the statements on ecological process innovations used in the questionnaire and their classification. These statements were grouped into 5 fields (minimizing negative emissions; recycling; energy and water savings; material savings; environmentally friendly products) as indicated by Sieg, Posadzińska, and Józwiak (2023).

Table 1.

Statements regarding green process innovations used in the study

Fields	Designation	Question
Recycling	Q2	In the last 3 years, my Department has been involved in new recycling processes.
	Q8	In the last 3 years, a waste utilization system has been implemented in my Department.

Cont. table 1.

Minimizing negative emissions	Q3	In the last 3 years, new processes reducing the emission of hazardous substances have been implemented in my Department.
	Q9	In the last 3 years, new procedures that reduce the need for transportation have been implemented in my Department.
Energy and water saving	Q5	In the last 3 years, energy-efficient renovations have been carried out in the buildings of my Department.
	Q6	In the last 3 years, new investments in the modernization of electrical installations have been implemented in my Department.
	Q10	In the last 3 years, lighting has been replaced with energy-efficient and/or motion sensor-equipped lighting in my Department.
	Q11	In the last 3 years, there has been a replacement of the central heating system in my Department.
	Q1	In the last 3 years, new processes reducing the consumption of electricity and water have been implemented in my Department.
Savings on materials	Q4	In the last 3 years, electronic document circulation has been implemented in my Department.
Eco-friendly products	Q7	In the last 3 years, new forms of collaboration with suppliers providing eco-friendly products and goods have been established in my Department.

Source: Own compilation based on the study.

In the prepared questionnaire, a Likert scale was utilized. The appropriateness of choosing the Likert scale for the following research was based on the justification proposed by Norman. Despite being a nominal scale, its application is necessary to facilitate analysis and calculations (Norman, 2010). The Likert scale is the most commonly used measurement tool in highly cited, peer-reviewed scientific articles in the field of management and quality sciences (e.g., Xie et al., 2019; Dana et al., 2021).

The collected data underwent statistical analysis. Statements regarding ecological process innovations were used to create an index called the departmental greening index. This index was constructed by calculating the arithmetic mean of responses to questions from Q1 to Q11 and could take values from 1 to 5. The reliability of the scale was assessed using Cronbach's alpha model. Additionally, in the analysis of the collected data, descriptive statistics were applied to describe the most important information about the studied ecological process innovations and the entities under investigation. Calculations were conducted using the Jamovi program.

4. Results

To assess the greening of public hospital departments in the Silesian Voivodeship, a composite index was developed in the first stage of the analysis, representing a compilation of all ecological actions undertaken by the department. Subsequently, the reliability of this index was evaluated using Cronbach's alpha model. Table 2 presents the Cronbach's alpha values for individual scale items, while Table 3 provides the Cronbach's alpha value for the scale consisting of 11 statements related to ecological innovations.

Table 2.

The Cronbach's alpha values for individual statements constituting the greening index of departments.

Cronbach's α	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	0.811	0.792	0.804	0.827	0.775	0.785	0.803	0.803	0.791	0.795	0.789

Source: Own compilation based on the study.

Table 3.

The Cronbach's alpha value of the departmental greening index

	Mean	SD	Cronbach's α
scale	5.78	1.98	0.813

Source: Own compilation based on the study.

Based on the Cronbach's alpha values, it was determined that the results are satisfactory; however, an analysis was conducted to ascertain whether removing any of the statements would enhance the results. The calculations carried out in this regard (Figure 2) indicated that removing item Q4 would improve the reliability of the index.

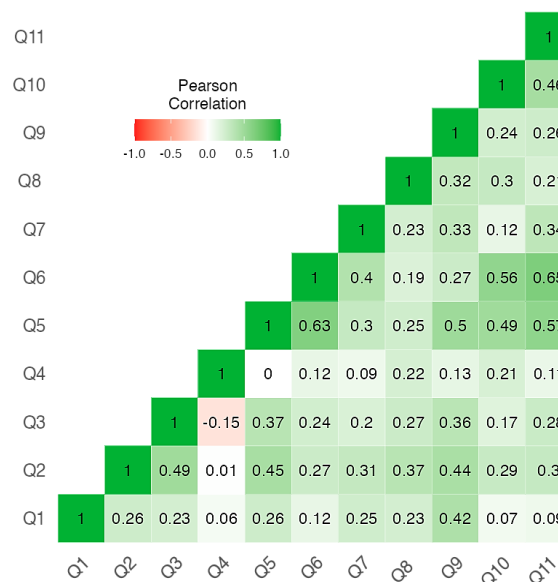


Figure 2. Correlation map for statements related to ecological process innovations.

Source: Own compilation based on the study.

After removing statement Q4, the reliability analysis of the hospital department greening index was conducted again. The obtained Cronbach's alpha results for individual statements and for the scale consisting of 10 statements are presented in Table 4 and Table 5, respectively.

Table 4.

Cronbach's alpha values for statements comprising the greening index of departments after excluding Q4

Cronbach's α	Q1	Q2	Q3	Q5	Q6	Q7	Q8	Q9	Q10	Q11
	0.826	0.806	0.816	0.788	0.801	0.819	0.822	0.807	0.814	0.805

Source: Own compilation based on the study.

Table 5.

Cronbach's alpha value and statistics for the greening index of departments after excluding Q4

	Mean	SD	Cronbach's α
scale	5.53	2.12	0.827

Source: Own compilation based on the study.

The results presented in Table 4 and Table 5, compared to Table 2 and Table 3, indicate that the exclusion of Q4 improved the Cronbach's alpha values. The Cronbach's alpha value for the greening index of public hospital departments is 0,827, indicating very good internal consistency of the analyzed questionnaire.

The greening index for the examined public hospital departments was 3,15, indicating a low level of activity in minimizing the negative impact on the environment by public hospitals. The values of the greening index for specific areas where ecological innovations were introduced in the surveyed hospitals, however, varied (Figure 2).

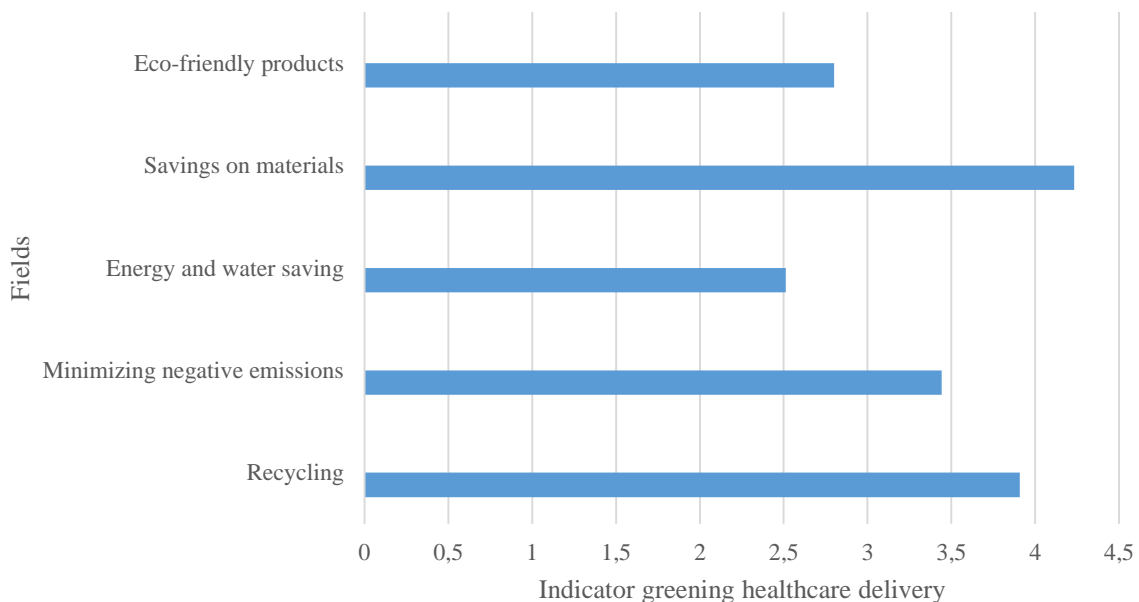


Figure 2. Greening index of hospital departments compared across areas.

Source: Own compilation based on the study.

The results presented in Figure 2. indicate that the greening index was highest in the field of material savings, where it reached 4,23, and in the area of recycling, with a score of 3,91. The area of energy and water savings had the lowest greening index in hospital departments, as it stood at 2,51. Based on the results, it can be inferred that the activity of hospital departments should be directed towards finding ecological solutions in areas with the lowest index.

To identify the environmental protection efforts undertaken in public hospital departments, a determinant of responses to statements about ecological activities was established. The obtained results indicate that in the surveyed healthcare facilities over the last 3 years,

projects related to building thermo modernization (Q5), new investments in the modernization of electrical installations (Q6), new procedures reducing the need for transportation (Q9), replacement of lighting with energy-efficient and/or motion sensor-equipped lighting (Q10), and central heating replacement were not undertaken (Q11). However, actions that were implemented in the surveyed healthcare facilities over the last 3 years included: new recycling processes (Q2), new processes reducing the emission of hazardous substances (Q3), implementation of electronic document circulation (Q4), and waste utilization system (Q8). Using the classification proposed by Sieg, Posadzińska, Józwiak (2023), it can be observed that the surveyed healthcare facilities least frequently undertook actions in the fields of energy and water savings, while they were most frequent in the areas of recycling and material savings.

The lowest greening index value was 1,45, occurring in the internal medicine department, employing 17 staff members, and averaging 850 patient hospitalizations per year. On the other hand, the highest greening index value was 5. This result was achieved by a nationwide hospital. It was also an internal medicine department, employing 40 staff members, and hospitalizing 500 patients per year. Departments belonging to nationwide hospitals include research institutes and clinical hospitals. They have access to higher funding than local and regional hospitals, as well as more qualified and informed personnel. Additionally, these hospitals are involved in research and development activities and the search for new service delivery solutions. Their responsibilities also include education and preparation for the medical profession. Therefore, departments belonging to nationwide hospitals tend to follow the latest knowledge.

5. Discussion

The study results indicate that ecological innovations are being implemented in public hospital departments. However, the healthcare delivery of Silesian hospital departments is moderate, as evidenced by the index value of 3,15. The study revealed that process innovations introduced in public hospitals in the last three years included recycling, reduction of CO₂ emission, material savings, and waste minimization. Recycling innovations involved waste segregation and waste disposal processes. Innovations aimed at reducing CO₂ emissions included procedures that reduce the need for transportation and minimize the emission of hazardous substances. Material savings activities mainly focused on the implementation of electronic medical documentation circulation.

The ecological innovations introduced in Silesian hospitals mainly related to areas for which new legal regulations obliging medical entities to apply specific solutions occurred during the studied period. For example, actions taken in hospitals in material savings could be significantly influenced by regulatory obligations in Poland since July 1, 2021, concerning the creation, storage, and exchange of electronic medical documentation. These regulations imposed

an obligation on national healthcare entities to maintain electronic medical documentation, which could have been a significant determinant for implementing new procedures in this area (Article 56 of the Act on the Information System in Healthcare). Similarly, ecological innovations introduced in public hospital departments in Silesia in the recycling area appear to be forced. On November 26, 2021, the Minister of Climate and Environment introduced a regulation on neutralizing and storing medical and veterinary waste, forcing hospitals to search for new solutions in this area. Financial support from the National Fund for Environmental Protection and Water Management (NFOŚiGW) for projects related to the construction or reconstruction of medical waste incinerators and thermal waste disposal systems could have influenced hospitals to undertake initiatives in this area. The Fund provided financial support to healthcare entities for investments related to the disposal of hospital waste, which could have influenced the projects undertaken by the units. Considering this situation, it seems that many of the process innovations introduced in hospitals in Silesia were not motivated by the desire to reduce CO₂ emissions but by necessity or cost reduction.

In the surveyed hospitals over the last three years, projects related to building term modernization, new investments in the modernization of electrical installations, and central heating replacement were rarely undertaken. The low activity of the surveyed hospitals in this area could be because NFOŚiGW could finance investments in the energy modernization of hospitals under hospital support programs that applied in the years 2016-2019, and this period was not considered in the study (the last three years cover the period from 2019 to 2022). NFOŚiGW financed activities such as thermo-isolation works, the use of renewable energy sources (RES), and the implementation of energy management systems, so the initiatives mentioned above could have been undertaken by the surveyed departments in previous years. The area where ecological innovations in hospitals were least frequently introduced was activities aimed at energy and water savings. That may be because energy and water consumption accompany the provision of services to patients, and savings in this area can lead to increased infections.

Considering the study results and the economic situation of many public hospitals in Poland, it can be assumed that implementing ecological innovations in Polish public hospitals may look similar in the future. Due to financial liquidity problems, these entities may need help to implement ecological innovations. Many hospitals would be willing to implement ecological innovations since they often reduce the costs of processes in organizations (Šumakarisa et al., 2021). However, they often lack the financial means to take steps in this field.

Conclusion

Like other modern organizations, public hospitals in Poland must comply with environmental regulations and policies. Therefore, healthcare units implement ecological goals in their strategies. However, although responsible management considering ecological innovations is becoming necessary, medical units' priority remains human health and life. Therefore, implementing ecological innovations in health units differs from other sectors.

The study presented in the article provides valuable information on the greening of Polish public hospitals. Thus, the study's results contribute to the development of knowledge about ecological innovation in healthcare units in Poland. Nevertheless, the survey has some limitations. The main limitation stems from the survey being conducted only among hospitals in Silesia, and it referred only to selected ecological innovations in the process. Expanding the survey to other regions of Poland and including a broader range of innovations would be worthwhile in the future. The determinants of ecological innovation are also worth exploring. The survey results may be used while creating instruments to support the implementation of sustainable development and legal regulations in this area.

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